IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 25, Issue 9 Ser. I (September. 2026), PP 58-66
www.iosrjournals.org

Fixed Orthodontic Appliances in Contemporary Practice: Conventional, Self-Ligating and Lingual Systems – An Updated Review

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Abstract
Background: *Fixed orthodontic appliances remain fundamental for comprehensive correction of malocclusion because they provide three-dimensional control of tooth movement. Conventional, self-ligating and lingual systems differ in ligation, biomechanics, visibility, cost, patient adaptation and clinical handling. Recent evidence has questioned several historical claims of superiority for particular bracket designs and has shifted attention toward individualized appliance selection, periodontal safety and patient-reported outcomes.*
Materials and Methods: *A narrative literature review was prepared from the source manuscript and updated with recent systematic reviews and meta-analyses published mainly in 2024–2026. The focused update considered conventional and self-ligating brackets, lingual appliances, periodontal and microbial outcomes, white-spot lesions, arch changes, customized appliances and orthodontically induced inflammatory root resorption.*
Results: *Conventional appliances remain predictable, versatile and cost-effective. Self-ligating brackets reduce ligation time and may offer modest early microbial or plaque-related advantages, but current evidence does not support a consistent clinically important reduction in total treatment duration or a major difference in arch development. Lingual appliances provide maximal concealment and can achieve comprehensive tooth movement, although they require specialized expertise and are associated with greater initial speech and tongue discomfort. Across systems, oral hygiene, force control, treatment complexity and patient-related risk factors remain more important than bracket type alone for many adverse outcomes.*
Conclusion: *No fixed-appliance system is universally superior. Appliance choice should be based on diagnosis, biomechanical requirements, periodontal condition, aesthetic expectations, cost, clinician experience and patient preference. Contemporary evidence supports a patient-centered approach rather than selection based on marketing claims or isolated mechanical advantages.*
Key words: *fixed orthodontic appliances; conventional brackets; self-ligating brackets; lingual orthodontics; periodontal health; root resorption; white-spot lesions.*

Date of Submission: 26-08-2026 Date of Acceptance: 06-09-2026

I. Introduction

Growth and development of the orofacial complex are strongly influenced by genetic factors, while environmental and functional influences may modify the expression of dentofacial characteristics. Disturbances in development may produce sagittal, vertical or transverse malocclusions and can affect facial appearance, oral function and psychosocial well-being. Orthodontic treatment therefore aims not only to align teeth, but also to establish functional occlusion, harmonious interarch relationships, periodontal health, facial balance and long-term stability.

Treatment planning is determined by the type and severity of the malocclusion, the patient's age and growth status, the required direction and magnitude of tooth movement, oral-health conditions, aesthetic expectations and anticipated cooperation. Fixed appliances are particularly useful when precise bodily movement, derotation, intrusion, extrusion, torque control or coordinated movement in several planes is required. Continuous engagement of the dentition also permits the clinician to control anchorage and to sequence complex movements more predictably than with many removable appliances.

The development of preadjusted edgewise appliances was a major transition in fixed orthodontics. Andrews incorporated prescribed tip and torque into bracket design, and subsequent prescriptions such as Roth

and MBT refined these concepts. Modern fixed treatment combines bracket prescriptions with nickel-titanium and stainless-steel archwires, elastics, springs and anchorage auxiliaries. The clinical result, however, is not determined by the bracket alone; bracket positioning, wire dimensions, force systems, biological response and patient cooperation all influence treatment.

Conventional brackets retain the archwire with elastomeric or wire ligatures. Self-ligating brackets use an integrated clip or sliding door and are commonly classified as active or passive. Their development was accompanied by claims of lower friction, faster alignment, fewer visits, improved hygiene, less pain and shorter treatment. Lingual systems place the appliance on the lingual or palatal tooth surfaces and were developed primarily to satisfy aesthetic demands while preserving the capabilities of fixed treatment. Customized digital workflows have further expanded lingual and labial fixed-appliance options.

The original source manuscript reviewed the components, indications, advantages and disadvantages of these three major fixed-appliance groups and emphasized individualized appliance selection. The present shortened but expanded publication version preserves that central comparison while removing historical repetition and incorporating recent evidence, particularly systematic reviews and meta-analyses from 2024–2026.

II. Materials and Methods

This paper is a narrative review based on the supplied comprehensive manuscript, with a focused contemporary literature update. The original manuscript searched PubMed, Google Scholar, Elsevier and Crossref and evaluated literature on the indications, components, advantages and disadvantages of conventional, self-ligating and lingual fixed appliances. For the present publication-oriented version, the material was reorganized into a concise structure modeled on the supplied IOSR paper format.

The update prioritized systematic reviews, meta-analyses and comparative clinical evidence published in 2024–2026 that addressed bracket-system effectiveness, periodontal health, microbial colonization, white-spot lesions, dental-arch changes, customized appliances and root resorption. Recent evidence was used to refine older claims where newer syntheses provide a more cautious interpretation.

The review question was framed around patients receiving comprehensive orthodontic treatment with fixed appliances. The principal comparisons were conventional ligated brackets versus active or passive self-ligating brackets, and labial versus lingual fixed appliances. Outcomes of interest included treatment efficiency, alignment, arch changes, torque and rotational control, periodontal and microbial parameters, enamel demineralization, discomfort, aesthetics, speech, root resorption and practical clinical considerations.

Because this is a narrative update rather than a de novo registered systematic review, no pooled analysis was performed in the present paper. Numerical findings from recent meta-analyses are reported only when they directly clarify the clinical interpretation. The final synthesis emphasizes the strength and consistency of evidence and avoids presenting theoretical or in-vitro advantages as established clinical benefits.

III. Results

1. Conventional fixed orthodontic appliances

Conventional preadjusted edgewise appliances remain the reference fixed system in everyday orthodontics. Brackets are bonded to the labial or buccal surfaces and connected to an archwire by elastomeric modules or stainless-steel ligatures. Their major strengths are familiarity, broad availability, relatively low cost and the clinician's ability to modify ligation, wire engagement and auxiliary mechanics at each visit. Conventional appliances can be used for mild to severe dental irregularities and for many cases requiring extraction space closure, substantial torque expression, rotational correction or interdisciplinary treatment.

The biomechanical performance of a conventional appliance depends on bracket prescription, slot dimensions, bracket position, archwire material and cross-section, ligation and the relationship between applied force and the tooth's center of resistance. Accurate bracket positioning is particularly important because errors in vertical height or mesiodistal placement can produce unwanted tip, torque or marginal-ridge discrepancies. Finishing commonly requires individualized wire bends or repositioning even with a preadjusted system.

Friction at the bracket–archwire–ligation interface is one limitation during sliding mechanics. Elastomeric ligatures can increase resistance to sliding and also create plaque-retentive areas. Nevertheless, friction is only one component of resistance to tooth movement. Binding, notching, wire stiffness, angulation, biological response and anchorage mechanics may be more important clinically. Consequently, lower laboratory friction does not automatically translate into faster treatment.

Fixed appliances create additional plaque-retentive surfaces and complicate brushing and interdental cleaning. Gingival inflammation and enamel white-spot lesions can develop when plaque control is inadequate. The risk is influenced by treatment duration, baseline enamel status, diet, fluoride exposure, salivary factors and adherence to preventive instructions. Preventive protocols, regular professional monitoring and early detection are therefore essential regardless of the bracket system.

Conventional appliances also remain relevant in the era of clear aligners because they can deliver complex force systems without depending on removable-appliance wear. They are particularly useful when compliance is uncertain or when movements such as large rotations, root movement, extrusion or complex space closure require continuous control. Their most obvious disadvantage for many adult patients is visibility, although ceramic and other aesthetic labial brackets can reduce this concern.

2. Self-ligating bracket systems

Self-ligating brackets retain the archwire by means of a built-in closure mechanism rather than a separate elastomeric or wire ligature. In active systems the clip may contact the archwire as wire dimensions increase; in passive systems a sliding door converts the slot into a tube-like lumen. Theoretical advantages include rapid archwire engagement, lower ligation-related friction and reduced chairside manipulation.

Early clinical promotion frequently suggested that self-ligating appliances could accelerate alignment, expand dental arches with less incisor proclination, reduce discomfort, improve hygiene, decrease the number of appointments and shorten total treatment time. The source manuscript appropriately noted that published findings have been inconsistent and that many orthodontists do not consider the additional cost justified when clear clinical benefits are absent.

Ramachandran et al. (2025) reported in a systematic review and meta-analysis that both passive self-ligating and conventional systems increased arch perimeter, but the between-system differences were neither clinically nor statistically significant [22]. These findings support the view that arch development is influenced more by the overall mechanics and archwire form than by self-ligation alone.

Coronel-Zubiate et al. (2024), in a systematic review and meta-analysis of 13 studies, found that self-ligating brackets probably performed better for plaque index and bleeding index, while probing depth and gingival index did not show clear differences [17]. These findings should not be interpreted as evidence that self-ligation eliminates hygiene risk; patient plaque control remains the dominant preventive factor.

Singaraju et al. (2025) evaluated time-stratified microbial colonization in passive self-ligating, active self-ligating and conventional brackets. Their systematic review and meta-analysis found a modest early microbial advantage for passive metal self-ligating brackets, especially during the first three months, but the certainty of evidence varied and no consistent periodontal superiority was established [25]. Thus, any microbial advantage appears modest rather than transformative.

Idris et al. (2025) systematically reviewed white-spot lesion formation with self-ligating versus conventional ligating brackets and found that the available evidence does not establish a simple protective effect based solely on bracket ligation [20]. In a broader 2025 meta-analysis, Hussain et al. included 57 studies and 9,101 patients and estimated a pooled white-spot lesion prevalence of 55.06%; longer treatment duration was an important risk factor [21]. This emphasizes prevention and monitoring rather than reliance on bracket design.

In practice, the most reproducible advantage of self-ligation is efficiency of archwire engagement and removal. This can shorten the ligation component of appointments, although total chair time also depends on procedures such as wire adjustment, repositioning, auxiliaries and oral-hygiene management. The higher purchase cost and mechanical complexity of the clip should therefore be weighed against the clinician's workflow and patient-specific needs.

3. Lingual fixed orthodontic appliances

Lingual orthodontics places brackets and archwires on the inner tooth surfaces, providing the highest level of concealment among fixed appliances. This makes the technique particularly attractive to adults and other patients who require comprehensive fixed treatment but strongly prefer an appliance that is not visible during smiling. Modern systems may be fully customized using digital setups, individualized brackets and robotically or digitally formed archwires.

Lingual and labial systems differ biomechanically because the point of force application is located on the lingual surface and closer to the tooth's center of resistance in some dimensions. The shorter interbracket distance, particularly in the anterior region, increases effective wire stiffness and can make rotations and finishing more technique-sensitive. Torque expression and vertical control therefore require careful planning and precise bracket placement.

The source manuscript identified deep-bite cases, selected Class II division 2 malocclusions, mild crowding, diastema closure and aesthetically demanding adult cases as potential indications. Contemporary evidence suggests that customized lingual systems can manage a broad spectrum of malocclusions when the clinician has appropriate expertise. Ahmed et al. (2024) concluded in a systematic review that lingual orthodontics is a viable aesthetic alternative to conventional labial treatment, although clinical selection and biomechanical expertise remain important [18].

The principal limitations are technical complexity, cost and adaptation. Indirect bonding or digital transfer is often used because direct visualization of the lingual surfaces is limited. Tongue irritation, speech

disturbance and chewing difficulty are common during early adaptation. Speech effects are generally more noticeable than with labial appliances because the brackets occupy the functional space of the tongue. Most patients adapt, but this issue should be discussed before treatment.

Oral hygiene around lingual brackets can also be challenging because of limited visibility. At the same time, some older studies reported fewer visible white-spot lesions on lingual surfaces than on labial surfaces. This does not remove the need for prevention because lingual demineralization and gingival inflammation may still occur. Professional monitoring is particularly important in patients with pre-existing periodontal susceptibility or limited dexterity.

Customized lingual appliances have been promoted as improving precision and reducing finishing requirements. Yassir et al. (2024) identified only four eligible comparative studies in their systematic review of customized versus noncustomized fixed orthodontic appliances and found broadly similar clinical effectiveness for most evaluated outcomes [19]. Customization may improve aspects of workflow and planned tooth positioning, but the available comparative evidence is insufficient to claim universal superiority.

4. Comparative clinical outcomes

Clinical factor	Conventional	Self-ligating	Lingual
Visibility	High, unless aesthetic brackets are used	Similar to labial appliances	Very low; appliance concealed
Clinical familiarity	Highest	High	Requires specialized training
Archwire ligation	Separate elastomeric/wire ligature	Integrated clip/door	System-dependent; often customized
Chairside ligation time	Longer	Usually shorter	Technique-sensitive
Total treatment duration	Predictable; case-dependent	No consistent major reduction	Case- and operator-dependent
Periodontal/plaque risk	Requires rigorous hygiene	Possible modest plaque/bleeding advantage	Hygiene can be difficult; close monitoring needed
Speech/tongue effects	Usually mild	Usually mild	More frequent early speech/tongue discomfort
Aesthetic acceptance	Lowest for metal brackets	Low–moderate	Highest among fixed systems
Cost	Generally lowest	Usually higher	Usually highest
Best use	Broad, versatile comprehensive treatment	Workflow preference; selected mechanics	Aesthetically demanding patients needing fixed control

Comparative evidence does not support a single bracket system as superior across all outcomes. Differences observed in laboratory friction studies are often reduced or disappear in clinical conditions. Tooth movement is a biological process, and its rate is limited by periodontal and alveolar remodeling rather than by bracket friction alone. Similarly, treatment duration is strongly affected by malocclusion severity, extraction pattern, missed appointments, breakages, finishing requirements and patient cooperation.

Pain and discomfort are greatest after appliance placement and wire changes and generally decline during adaptation. Some studies have reported lower pain with self-ligating systems, but the overall evidence has not shown a consistent clinically important advantage. Lingual appliances have a distinct discomfort profile dominated by tongue irritation and speech alteration, particularly early in treatment.

Torque and rotational control depend on slot–wire play, bracket prescription, wire dimensions, material properties and bracket placement. Conventional systems remain highly effective during finishing because the clinician can use tight ligation and individualized wire adjustments. Self-ligating brackets can also provide appropriate torque when sufficiently dimensioned wires are engaged, but the clip design and slot tolerances influence expression. Lingual systems can provide excellent control but require a different biomechanical approach.

Aesthetic preference can be decisive. The source manuscript emphasized that many patients are willing to accept additional cost for less visible treatment. Contemporary patient-centered care therefore requires discussion of appliance visibility together with the practical trade-offs in comfort, hygiene, cost and technical complexity.

5. Adverse effects and safety considerations

External apical root resorption is a recognized potential adverse effect of orthodontic tooth movement. Risk is multifactorial and is influenced by individual susceptibility, root morphology, treatment duration, magnitude and direction of movement, previous trauma and the amount of apical displacement. It should not be attributed to a bracket type in isolation.

Kreuter et al. (2025) performed a CBCT-based meta-analysis comparing aligners, self-ligating appliances and conventional fixed appliances. Five studies with 334 participants were included; for maxillary incisors, differences between aligners and fixed appliances did not reach statistical significance, and average resorption in the evaluated groups was below 1 mm [23]. Appliance selection should therefore be based on biomechanics, expected outcomes and patient preferences rather than on bracket type alone in patients without special risk factors.

Another 2025 systematic review and meta-analysis examining root-canal-treated teeth during fixed appliance therapy found no significant overall difference in root resorption compared with vital teeth. Although this question is more specific than bracket selection, it illustrates the broader principle that root-resorption risk must be evaluated at the patient and tooth level rather than through generalized assumptions about appliance type.

White-spot lesions and gingival inflammation are among the most preventable complications. Baseline oral hygiene should be satisfactory before bonding. Patients should receive individualized instruction on toothbrushing, interdental cleaning, fluoride use and diet. High-risk patients require more frequent recall and professional preventive measures. Appliance choice can influence plaque-retentive features, but prevention depends primarily on sustained behavior and monitoring.

Bracket debonding, soft-tissue irritation and mucosal ulceration may interrupt treatment. Conventional and self-ligating labial brackets primarily affect the lips and cheeks, whereas lingual appliances affect the tongue. Hard or sticky foods increase the risk of bracket failure in all systems. Patients should understand how breakages can prolong treatment and compromise planned mechanics.

6. Contemporary perspective: digital workflows and evidence-based appliance choice

Evidence-based appliance selection therefore combines the best available research with clinical expertise and patient values. The orthodontist should consider whether a proposed advantage is clinically meaningful, whether it applies to the specific patient and whether it justifies additional cost or complexity. When evidence is uncertain, that uncertainty should be communicated rather than replaced by absolute claims.

The rapid introduction of new bracket designs makes evidence appraisal essential. Marketing claims often emphasize mechanical features that are easy to demonstrate in vitro, while clinically important outcomes such as total treatment duration, quality of finishing, adverse effects and patient satisfaction require controlled clinical studies. Recent systematic reviews repeatedly show that differences between bracket systems are smaller than early promotional claims suggested.

Digital orthodontics has changed diagnosis, treatment simulation, indirect bonding and appliance manufacturing. In fixed treatment, digital setups can be used to plan bracket positions, fabricate transfer trays and customize bracket bases or archwires. These tools can improve reproducibility and communication, particularly for lingual appliances where direct access is difficult. Nevertheless, a digital setup represents a treatment plan, not a guarantee that biological tooth movement will exactly reproduce the virtual prediction.

7. Oral hygiene, prevention and monitoring during fixed treatment

Radiographic monitoring should be individualized rather than routine at unnecessarily short intervals. Patients with unusual root morphology, previous trauma, substantial apical movement or early evidence of resorption may require closer evaluation. If clinically important resorption is detected, treatment goals, force levels and remaining treatment duration should be reconsidered. This risk-management approach is more evidence-based than assuming that one bracket design is inherently safe.

Periodontal monitoring should include gingival inflammation, bleeding, plaque accumulation and, when indicated, probing depths. Patients with persistent inflammation should receive additional professional cleaning and reinforcement of home care. In severe cases, active orthodontic mechanics may need to be modified or temporarily paused until inflammation is controlled. The small periodontal differences reported between bracket types do not replace this clinical responsibility.

White-spot lesions may develop within a relatively short period when plaque remains around brackets. The recent evidence showing a high pooled prevalence during orthodontic treatment reinforces the need to document pre-existing lesions at baseline. Clinical photography and careful enamel examination help distinguish lesions that predate treatment from those that develop during therapy. Early identification allows preventive measures to be intensified before cavitation occurs.

During treatment, patients should be instructed to clean above and below the bracket wings and to use interdental brushes or other aids where appropriate. Fluoride toothpaste is essential, and additional topical fluoride

may be indicated in patients at increased caries risk. Dietary counseling should focus on limiting the frequency of fermentable carbohydrate exposure as well as avoiding foods that can damage the appliance.

Bonded brackets alter the local oral environment by creating retentive areas around bracket bases, ligatures and gingival margins. Plaque can mature rapidly if brushing is ineffective, increasing the risk of gingival inflammation and enamel demineralization. Orthodontic prevention should therefore begin before bonding, with treatment of active caries, stabilization of periodontal disease and demonstration of adequate plaque control.

8. Indications, contraindications and patient selection

Patient expectations should be explored before appliance placement. Visibility, comfort, anticipated duration, appointment frequency and cost are interpreted differently by different patients. A technically sophisticated appliance is not necessarily the best option if its disadvantages conflict with the patient's priorities. Shared decision-making improves the quality of consent and may also improve cooperation during treatment.

Adult patients require particular attention to periodontal condition, restorations, missing teeth and previous endodontic treatment. Reduced periodontal support does not necessarily preclude orthodontics, but lighter forces, careful control of inflammation and interdisciplinary coordination may be required. Treatment goals may also differ from those in adolescents and can include pre-prosthetic space redistribution, correction of tooth inclination and improvement of periodontal architecture.

Lingual treatment is especially appropriate for patients with high aesthetic demands who still require the control of a fixed appliance. Suitable patients should understand the adaptation period and be able to maintain excellent oral hygiene. Short clinical crowns, severe periodontal compromise, limited lingual access, marked tongue sensitivity or unwillingness to accept speech adaptation may complicate treatment. These factors are relative rather than absolute and depend on the appliance design and clinician experience.

Self-ligating brackets can be selected for the same general indications as conventional labial brackets. They may be attractive in practices that value rapid archwire changes or prefer a particular low-ligation-force philosophy during initial alignment. They should not, however, be selected on the assumption that they will automatically avoid extractions, create basal bone expansion or substantially shorten treatment. Extraction decisions must remain diagnosis-based and should consider crowding, incisor position, facial profile, periodontal boundaries and stability.

Conventional fixed appliances are appropriate for a very broad range of malocclusions, including moderate and severe crowding, extraction and non-extraction treatment, deep bite, increased overjet, crossbite correction and cases requiring detailed finishing. Their versatility makes them particularly suitable when the treatment plan may need to be modified during therapy. Relative limitations are primarily aesthetic and hygiene-related rather than biomechanical.

9. Components and biomechanical considerations

Torque is especially important in the maxillary incisors because buccolingual inclination influences overjet, arch length, incisor display and smile aesthetics. Full expression of prescribed torque requires an adequately dimensioned rectangular wire, accurate bracket placement and sufficient engagement. Slot–wire play means that the nominal prescription is not necessarily fully expressed clinically. Finishing therefore remains an active process in all bracket systems.

Sliding mechanics illustrate why laboratory friction should be interpreted cautiously. When a tooth tips relative to the archwire, the wire contacts the edges of the bracket slot and binding can become more important than simple friction from ligation. As tooth movement proceeds, biological resistance, wire deflection and contact geometry change continuously. For this reason, a bracket that demonstrates very low friction in a laboratory model may not produce proportionally faster movement in a patient.

Anchorage control is fundamental from the beginning of treatment. Space closure, incisor retraction, molar movement and correction of asymmetry can produce reciprocal forces that move teeth away from the intended position. Anchorage may be reinforced with transpalatal or lingual arches, intermaxillary elastics, headgear or temporary anchorage devices. The bracket system itself does not remove the need for careful anchorage planning.

Archwires are selected according to treatment stage. Flexible nickel-titanium wires are widely used during initial alignment because they can deliver relatively light continuous forces over a broad range of activation. Rectangular nickel-titanium and stainless-steel wires are subsequently used when greater control of torque, arch form and space closure is required. The transition from small round wires to larger rectangular wires should reflect the biological response and the amount of correction required rather than a rigid calendar-based sequence.

Orthodontic brackets transmit forces and moments from the archwire to the tooth. Bracket width, slot dimension, material, prescription and manufacturing tolerance influence the amount of play between wire and slot and therefore affect torque expression. Stainless-steel brackets generally provide a rigid slot surface, whereas

ceramic brackets offer improved aesthetics but may differ in friction and brittleness. In clinical treatment, these material differences must be considered together with the chosen archwire and the intended stage of treatment.

A fixed orthodontic appliance is a coordinated system rather than an isolated bracket. Passive components include brackets, molar tubes or bands, buttons, hooks and other attachments, while active components include archwires, springs, elastics and auxiliary force-delivery elements. Temporary anchorage devices may be incorporated when conventional dental anchorage is insufficient. The interaction among these elements determines the direction, magnitude and duration of the force applied to the periodontal ligament.

IV. Discussion

The central clinical question is not which bracket is universally best, but which appliance best matches the diagnosis and the patient. The original manuscript described numerous theoretical and historical advantages for each system. The recent literature makes it possible to separate reproducible clinical benefits from claims that are mainly based on laboratory mechanics or early observational studies.

For conventional appliances, the major advantages remain versatility, predictable control, broad clinician experience and cost-effectiveness. Their disadvantages are visibility, the need for separate ligation and plaque-retentive components. These limitations are real, but they can often be managed through aesthetic bracket options, efficient clinical workflows and rigorous preventive programs.

For self-ligating appliances, lower ligation-related friction and faster wire engagement are mechanically plausible and clinically demonstrable. However, the stronger claims of markedly faster overall treatment, substantially less pain or major spontaneous arch development are not consistently supported by contemporary evidence. The 2025 arch-perimeter meta-analysis found no significant advantage over conventional brackets, while recent periodontal and microbial syntheses suggest only modest benefits in selected early parameters.

This distinction is important for informed consent. Patients should not be told that self-ligating brackets will necessarily shorten treatment or eliminate extractions, pain or hygiene problems. Instead, they can be presented as an alternative ligation design that may improve some aspects of chairside efficiency and may modestly influence plaque or microbial accumulation, with overall outcomes still determined by the treatment plan and biological response.

Lingual appliances occupy a different clinical niche because their primary advantage is concealment rather than simplified mechanics. They can provide comprehensive fixed treatment and modern customized systems have improved precision. Their disadvantages—cost, technique sensitivity, tongue discomfort and speech adaptation—remain clinically relevant. Appropriate case selection and clinician training are therefore essential.

The 2024 review of customized versus noncustomized appliances also highlights an important theme in modern orthodontics: digital customization is advancing faster than high-quality comparative clinical evidence. Digital setups, individualized bracket bases and customized wires can improve planning and manufacturing consistency, but clinicians should distinguish technological sophistication from proven superiority in patient outcomes.

Periodontal safety has become increasingly important as more adults seek orthodontic treatment. Coronel-Zubiate et al. (2024) reported a probable advantage for self-ligating brackets in plaque and bleeding indices, but not in probing depth or gingival index [17]. Singaraju et al. (2025) similarly found modest early microbial benefits for passive self-ligating brackets, while emphasizing heterogeneity and limitations in the evidence [25]. These findings support careful hygiene management for every fixed-appliance patient.

The recent evidence on white-spot lesions is especially relevant. Idris et al. (2025) found no consistent difference in white-spot lesion formation between self-ligating and conventional ligation across most included studies [20]. Hussain et al. (2025) estimated a pooled prevalence of 55.06% and an incidence of 34.2% among orthodontic patients, with prevalence increasing as treatment duration increased [21]. Efficient treatment planning, avoidance of unnecessary delays and consistent preventive protocols may therefore be more clinically important than selecting a bracket based on an assumed anti-caries advantage.

Root resorption should be approached through risk stratification rather than appliance marketing. Kreuter et al. (2025) did not demonstrate a statistically significant difference between aligner and fixed modalities for maxillary-incisor root resorption in the available CBCT evidence [23]. For fixed treatment, prudent force application, radiographic monitoring in susceptible patients and modification of mechanics when significant resorption is detected remain appropriate clinical strategies.

Patient-reported outcomes should be incorporated into appliance selection. An adult professional who places a very high value on appliance concealment may reasonably prefer lingual treatment despite higher cost and early speech adaptation. Another patient may prioritize simplicity and cost and choose conventional metal brackets. A clinician may prefer self-ligating brackets because of workflow efficiency without claiming biological superiority. These are legitimate individualized decisions.

Modern orthodontic philosophy therefore favors shared decision-making. The orthodontist should explain what each appliance can realistically achieve, which disadvantages are most likely, what evidence is

uncertain, and which factors depend on patient behavior. The appliance is one component of a broader treatment system that includes diagnosis, biomechanics, anchorage, prevention, monitoring and retention.

The review has limitations. It is a narrative publication-oriented synthesis derived from an existing broad manuscript and supplemented by a focused update rather than a newly registered systematic review. The recent literature itself includes heterogeneity in bracket designs, treatment protocols, follow-up periods and outcome definitions. Conclusions should therefore emphasize clinically consistent patterns rather than isolated statistically significant findings.

V. Conclusion

Conventional, self-ligating and lingual fixed orthodontic appliances are all capable of producing successful treatment when appropriately selected and managed. Conventional brackets remain the most familiar and cost-effective comprehensive system and provide predictable three-dimensional control. Self-ligating brackets simplify archwire engagement and may offer modest early plaque or microbial advantages, but recent evidence does not support a consistent major reduction in total treatment duration or a clinically meaningful superiority in arch development. Lingual appliances provide the greatest aesthetic concealment and can manage complex treatment, but they require specialized expertise and involve higher cost and greater early speech and tongue discomfort.

The most recent evidence strengthens the principle that bracket design alone should not determine treatment. Diagnosis, biomechanics, oral-health status, root-resorption risk, aesthetic expectations, cost, clinician competence and patient cooperation should guide appliance selection. Preventive care and monitoring remain essential for all fixed systems. A patient-centered, evidence-based approach is more appropriate than universal preference for any single bracket technology.

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